# *Office of Power Technologies Strategic Plan*

## *Clean, Competitive, Reliable Power Technologies for the 21st Century*

U.S. Department of Energy • Energy Efficiency and Renewable Energy

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*HTS Motor photo courtesy of Rockwell Automation.*

**U.S. Department of Energy**
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In 2020, a diverse and competitive electricity marketplace exists where the OPT portfolio of renewable and natural gas energy systems is widely implemented and provides clean, reliable, and cost-competitive choices.

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# Introduction

The Office of Power Technologies (OPT) manages research and development (R&D) programs for an integrated portfolio of renewable and natural gas energy technologies, as well as energy storage and power delivery systems, that show promise for meeting the Nation's need for producing clean, efficient, and cost-competitive power. Further, OPT facilitates the effective deployment of these technologies to maximize their benefits to the Nation.

This Strategic Plan is the basis for the actions and activities that OPT will implement to assure that its programs and associated activities significantly contribute to achieving the goals and objectives of the Department of Energy (DOE) and the Office of Energy Efficiency and Renewable Energy (EERE). The OPT Strategic Plan aligns with the DOE and EERE strategic plans and addresses OPT's role within EERE. Many of the technology and deployment facilitation programs under OPT are also driven by a program-specific strategic plan consistent with the broader drivers, goals, and strategies herein, and these plans provide more detail on the full scope of OPT endeavors through the year 2020. These documents, as well as specific information for each individual program, may be found at the OPT website located at http://www.eren.doe.gov/power.

**OPT Portfolio**

- Biopower
- Concentrating Solar Power
- Geothermal Energy
- Hydroelectric Power
- Photovoltaics
- Solar Buildings
- Wind Energy
- Energy Storage
- Hydrogen
- Superconductivity
- Transmission Reliability
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- International

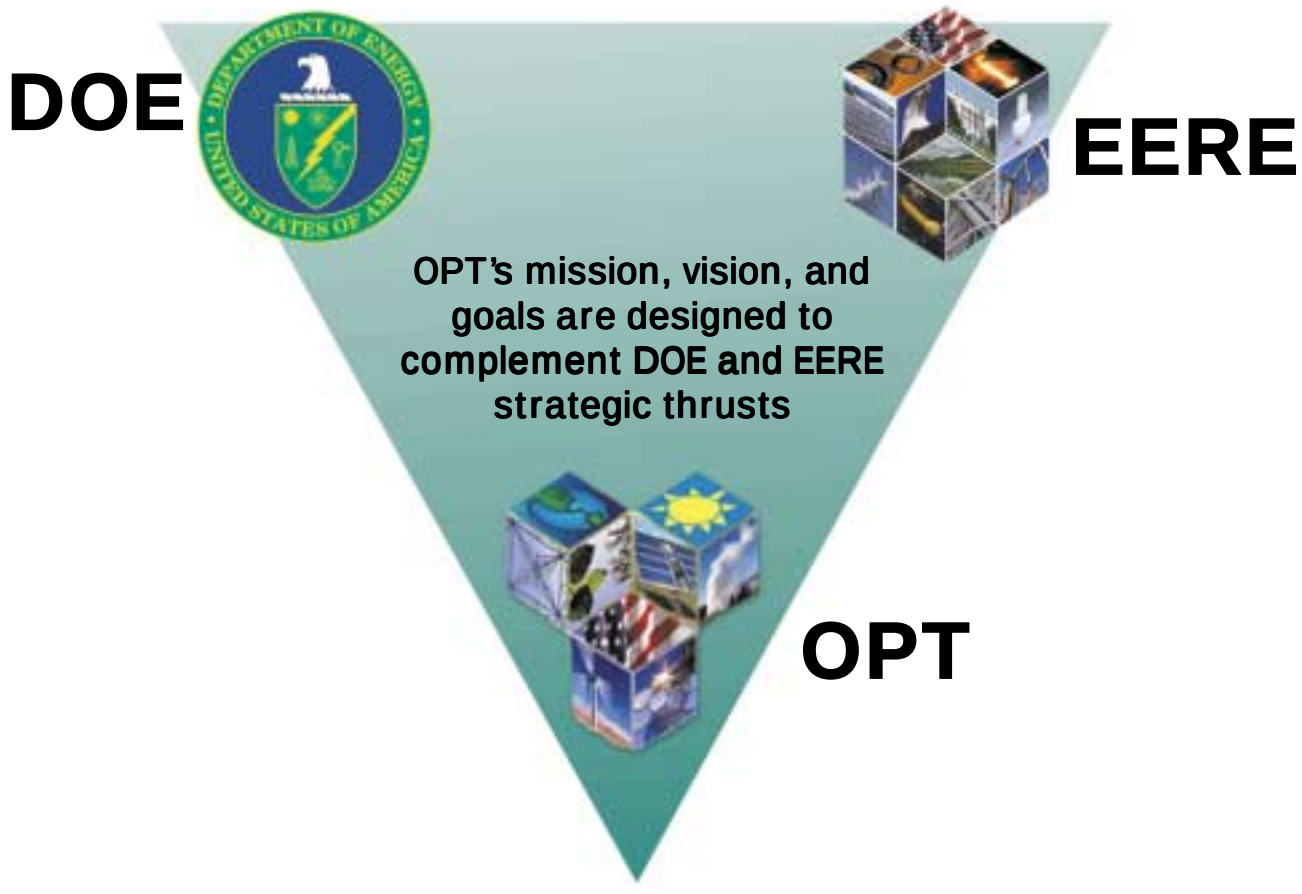
In defining its mission, vision, goals, and strategies, OPT continually analyzes the power sector and its outlook to ensure that OPT's programs are focused on those activities, consistent with a proper Federal role, that will fulfill critical national interests and meet program goals in an efficient and cost-effective manner. OPT also takes the needs of its stakeholders, partners, and customers into consideration when developing its long-term goals and strategies. OPT recognizes that these groups are ultimately responsible for choosing and deploying its portfolio of programs, and thus works closely with these parties in both its technology development and deployment facilitation efforts in order for the public to receive the full benefit from Federal investments in these areas. Finally, through the use of individual program reviews, OPT annually reexamines its portfolio of programs to assure the appropriate balance both among and within programs. In conjunction with these efforts, OPT will also conduct periodic reviews of its Strategic Plan to ensure that it evolves in conjunction with changes in the power sector, OPT programs, and Administration and Department policy.

# Mission

*To lead the national effort to develop and support clean, competitive, reliable renewable energy, distributed natural gas, and power delivery technologies for the 21st century.*

# Vision 2020

*In 2020, a diverse and competitive electricity marketplace exists where the OPT portfolio of renewable and natural gas energy systems is widely implemented and provides clean, reliable, and cost-competitive choices.*



# Situation Analysis

A brief situation analysis of five areas of the power sector environment that influence OPT programmatic decisions follows:

## Resource Competition

Currently, coal and nuclear power account for approximately 52% and 19% of U.S. electricity generation respectively (Energy Information Administration (EIA), 2000). However, coal-fired generation is being affected by growing concerns over the environmental impacts of these plants, as well as by higher capital costs relative to gas-fired generation. Similarly, the role of nuclear power has been limited by public concerns over plant safety and waste disposal, and as a result, EIA projects that more than half of the existing nuclear generating capacity will retire by 2020.

Natural gas, with its relatively low price and plentiful supply, is projected to continue to provide an increasing portion of the Nation's power in the years to come; however, the need for additional pipelines may affect the expansion and costs of utilizing this resource in some areas of the U.S. Continued improvements in technology performance and cost reduction will enable renewable energy resources to capture an ever increasing share of capacity additions.

## Reliability

Rising consumer demand for electricity and constraints on building new transmission and distribution (T&D) systems have the potential to negatively impact system reliability. Advanced T&D system technologies will thus be required to provide real-time systems monitoring and control and ensure power quality. Additionally, these same factors will also create more opportunities for distributed renewable and natural gas energy systems as clean, efficient, and reliable power alternatives.

## Industry Restructuring

Electricity markets across the country are rapidly being opened to competition, thus allowing customers to choose among power technologies, suppliers, and types of electricity services and products. Restructuring has spurred the growth of a "green power" market offering those with an interest in cleaner energy the opportunity to purchase renewable resources. Customer choice has also promoted the further development and deployment of distributed energy resources that can be tailored to fit a variety of end-user needs including reduced emissions, improved reliability, lower costs, and greater flexibility.

## Environment

Nationally, electricity generation is the largest source of air pollution and emission of gases that may cause global warming. According to the Environmental Protection Agency (EPA), electric utilities are responsible for 64% of $SO_2$ and 26% of $NO_x$ emissions. Additionally, electricity generation contributes 37% of U.S. carbon emissions resulting from human activities. One of the greatest challenges that fossil energy faces is a wide and expanding range of clean air regulations that pressure the industry's growth. Continued emphasis on environmental issues will be a key factor affecting the growth of renewable energy industries.

## Private Sector Activities

Privately-funded electric sector R&D, particularly for renewable energy technologies, has decreased sharply in the context of marketplace uncertainty, increased competition, and the current focus on low-cost energy. In the changing power industry, utilities are switching their focus from long-term R&D projects to short-term projects and needs. Thus, the importance of Federally-supported R&D increases.

# Strategic Drivers

OPT's Advanced Microturbine Systems program is working to boost microturbine efficiency and lower emissions.

OPT's programs respond to five national strategic drivers:

## Energy Security

Through advancement of energy-efficient power technologies and increasing the use of renewable energy sources, OPT programs help reduce costly energy imports and our Nation's trade deficit. In addition, because renewable resources are wholly domestic, they are insulated from major supply disruptions in the world's energy markets.

## Economic Competitiveness

OPT's energy programs are designed to maintain the U.S. technological expertise and competitive advantage in the global market. OPT-sponsored programs to promote renewable energy internationally not only lay the foundation for a more sustainable energy future, but also help to open markets and increase exports of proven U.S. technologies. Domestically, by promoting the reliability of the electric grid, OPT's programs also help to ensure competitive electricity prices and the long-term competitiveness of all U.S. industries.

## Environmental Quality

OPT programs work to mitigate and minimize the environmental costs of energy use. By developing energy-efficient renewable and natural gas technologies, OPT is concurrently identifying ways to reduce energy-related air pollutants and help the U.S. meet national emissions goals.

## Climate Change

Early development and deployment of renewable energy technologies can play a critical role in reducing greenhouse gas emissions. Given the cost savings associated with the use of these technologies, aggressive investments in clean energy technologies and their deployment could lead to significant emissions reductions without raising the Nation's net energy bill.

## Electric Restructuring

OPT provides technical assistance to State and Federal officials regarding policy and market mechanisms to achieve their energy efficiency and renewable energy goals in a restructured energy marketplace. Electric restructuring presents an opportunity to reduce energy costs, advance the use of renewable energy technologies, and provide affordable services with reduced environmental impacts.

# Goals

Based on OPT's analysis of the evolving power sector environment, the status of OPT technologies, and the market barriers to the effective development and deployment of these technologies over the next ten years, OPT has identified the following goals which warrant an increased Federal role:

- Enhance the use of renewable energy, triple the installed U.S. capacity of non-hydroelectric renewables by 2010, and maintain the viability of hydropower
- Enable distributed energy resources to achieve 20%+ of new generation capacity by 2010
- Maintain the present high reliability of the Nation's electricity system
- Continuously improve OPT management and operations and enhance our partnering capabilities

The first U.S. industrial installation of a Superconducting Power Cable, located at the Southwire Company in Carrollton, Georgia. The 3-phase line, which supplies 1,250 A at 12.4 kV, began delivering power on February 18th, 2000.

# Strategies

DOE's partnership with industry at the Dixie Valley geothermal power plant has yielded important technology improvements that will benefit all future users of geothermal energy.

OPT has identified four strategic thrust areas which are critical for advancing its mission, achieving its vision, and attaining its goals.

## Research, Development, and Technology Field Validation

Through its partnerships with National Laboratories, academic institutions, and the private sector, OPT supports a broad spectrum of basic and applied research, technology development, and field validation activities. OPT's R&D efforts are focused on improving technology performance, lowering costs, and enhancing efficiency, reliability, and lifetimes. Field validation activities are designed to ensure that technologies operate as expected when integrated into electricity grids or placed at customer sites. These activities are critical for establishing technology credibility in electric power markets.

For all of these programs, cost-sharing with the private sector is encouraged, and the private sector share tends to increase along the research-development-evaluation spectrum to the point that it represents a significant portion of total funding at the field validation level.

Detailed descriptions of OPT's R&D programs are available on OPT's website (www.eren.doe.gov/power).

## Technology Deployment Facilitation

Realization of the benefits of OPT technologies requires their use in the electricity marketplace. While market players have the primary responsibility for determining which technologies are successful in the marketplace, there are major informational, financial, and institutional barriers to the penetration of these technologies.

For these reasons, OPT supports a number of activities designed to address and mitigate these barriers. These include: development and dissemination of information through publications, conferences, brochures, and the Internet to help expand knowledge and awareness of OPT technologies; technology assistance (and sometimes financial support) for specific projects, especially when they will provide needed information on the performance and benefits of these technologies; providing leadership for broad Federal initiatives that make substantive contributions toward advancing the utilization of OPT technologies; and participation in collaborative activities with industry that seek to eliminate regulatory and institutional

barriers to broader technology deployment.

## Policy Formulation

In order to plan and manage its advanced power technology R&D and field validation programs effectively, OPT actively participates in policy formulation and analysis. OPT policy interests include electricity restructuring, the implications of renewables portfolio standards and system benefits charges, the costs and benefits of various tax incentives for advanced technologies, and the implications of environmental regulations and carbon emissions control programs on the electric sector.

In its policy role, OPT works in close collaboration with other DOE offices, including DOE regional offices, the DOE Office of Policy, other Federal agencies, and interested parties in Congress. OPT also provides technical assistance in policy formulation and analysis to State and local decision-makers in response to their needs and requests.

## Management

Effective and responsible management is essential for the achievement of OPT's mission and goals. OPT has streamlined its organizational structure in an effort to provide better management of its programs, to utilize OPT human and financial resources more efficiently, to improve our responsiveness to stakeholder needs, and to enhance communications and trust within OPT and with our partners both in DOE and industry.

In conjunction with the overall framework established by EERE's Strategic Management System, OPT continually strives to improve its management and operations in four specific areas: planning, budget formulation, budget execution, and program analysis and evaluation.

OPT utilizes the requirements of the Government Performance and Results Act (GPRA) as an aid to effective program management. OPT develops strategic plans for each program describing their overall goals and objectives and establishes annual performance plans containing quantifiable measures of their progress. Each program also develops five-year program plans outlining their R&D agendas, technology development milestones, and program integration and industry outreach activities.

OPT seeks to base its annual budget requests on the most solid program planning, analysis, and evaluation available to ensure the prudent use of Federal resources. OPT strives to award an increasing percentage of its discretionary financial assistance funding on a competitive basis each year and to maintain its uncosted obligations at a reasonable level.

OPT participates in regular assessments of its management systems and continually implements improvements recommended through the review process. OPT ensures that its programs remain performance based through regular tracking and reporting of their success in meeting the performance standards and measures developed under GPRA requirements.

Finally, OPT seeks to improve its employee development programs in an effort to build and retain a diverse workplace, increase its customer-service orientation, and reward employees for creativity, innovation, and overall excellence.

The Biopower Program successfully demonstrated sustained operation of the Battelle / FERCO advanced biomass gasifier in Burlington, Vermont.

# Current Programs

## Biopower

The Biopower Program is working to integrate biomass feedstock and power conversion systems that are competitive with conventional fossil-based options. OPT is developing advanced conversion systems to utilize biomass-derived fuels more cleanly and efficiently than current technology.

## Concentrating Solar Power

Various mirror configurations are used to concentrate the heat of the sun to produce emission-free electric power. The Concentrating Solar Power Program is working to develop high-reliability distributed power systems; reduce the costs of dispatchable solar power; develop advanced components and systems; and ensure that research and development efforts are focused on industry needs.

## Geothermal Energy

The Geothermal Energy Program sponsors research aimed at developing the technologies necessary for tapping the geothermal energy resource to the greatest extent and establishing geothermal energy as an economically competitive contributor to the U.S. energy supply.

## Hydropower

The Hydropower Program aims to develop advanced technology that will allow the Nation to maximize the use of hydropower resources, while minimizing adverse environmental effects. The main focus is on the development of a "fish-friendly turbine" that will minimize fish mortality, while increasing the efficiency of power production.

## Photovoltaics

The Photovoltaic Technology Program conducts fundamental and applied research in materials and device development, manufacturing processes, module reliability, and system testing and evaluation. Efforts are directed toward achieving critical gains in efficiency, manufacturability, and system longevity to assure photovoltaics' place in the competitive marketplace.

## Solar Buildings Technology

The Solar Buildings Technology Program conducts research that is essential to the development of solar technologies to provide hot water, space heating, and cooling to residential, commercial, and industrial buildings. The focus is on a new generation of solar water heaters that are expected to be half as expensive as today's technology.

## Wind Energy

The mission of the Wind Energy Systems Program is to enable the U.S. wind industry to complete the research, testing, and field verification needed to develop fully advanced wind energy technologies that lead the world in cost-effectiveness and reliability.

## Distributed Energy Resources

In January 2000, DOE launched the Distributed Energy Resources Taskforce to combine DER-related programs of EERE in one office to enhance the effectiveness of research, development, demonstration, education, and implementation activities. The Taskforce, working with its industry partners, is crafting a plan to capitalize on the synergy generated by bringing all clean distributed energy resource programs together in one place. Supported DER technologies include advanced turbines, advanced engines, fuel cells, microturbines, and combined heat and power applications.

## Energy Storage

The Energy Storage Program develops technologies and systems which will contribute to the reliability and enhance the power quality of the Nation's electricity supply system. As an enabling technology, energy storage systems will optimize integration of renewable and hybrid power generation.

## Hydrogen

The Hydrogen Program supports cost-shared research projects with industry on hydrogen production by gasification, reforming, petrochemical and photobiological processes. Recent experiments show that production of hydrogen from biomass and fossil fuels could be cost-effective, and OPT plans to further test these results on integrated systems.

## High Temperature Superconductivity

High Temperature Superconductivity has the potential to bring about an energy revolution as profound as the impact that fiber optics had on telecommunications. The Program supports first-of-a-kind development of electric power devices to capture the full energy and economic potential of superconductivity.

## Transmission Reliability

The Transmission Reliability Program focuses on applying advanced computing, sensing, power electronics, communications, and control technologies to provide real time system control for reliable and efficient operation of the Nation's electric power system under both normal and emergency operating conditions.

## Climate Challenge

The Climate Challenge is a voluntary venture between electric utilities and the U.S. Department of Energy, as part of the U.S. response to the 1992 Rio Treaty, which mandated international stabilization of greenhouse gas emissions. Under the program, 124 individual participation agreements exist (representing 650 electric utilities) which contain pledges to undertake a wide variety of voluntary actions to reduce, sequester, or avoid greenhouse gas emissions.

## Electricity Restructuring

Through its Electricity Restructuring activities, OPT provides technical assistance to State and Federal officials and others regarding policy and market mechanisms to achieve their energy efficiency and renewable energy goals in a competitive marketplace.

The 107MW wind farm in Lake Benton, Minnesota produces electric power at an unsubsidized cost of $0.04 per kWh.

## International

OPT's International activities support the expansion of U.S. renewable energy and energy efficiency technology exports to help meet the energy needs of developed and developing countries, reduce the rate of consumption of finite global resources, and address local and transnational environmental issues. Program support is provided in three broad areas:

- Emerging Global and Energy Issues (U.S. Initiative on Joint Implementation),
- Market and Trade Development, and
- U.S. Energy and Environmental Security.

## Renewable Energy Production Incentive

As a deployment facilitation mechanism, the Renewable Energy Production Incentive provides incentive payments to qualified electric power plants, that are owned by State or municipal electric utilities, or by non-profit electrical cooperatives, who produce electricity from solar, wind, geothermal, or biomass energy.

## Renewable Indian Energy Resources

Renewable Indian Energy Resources activities assist American Indian Tribal Governments and their entities in gaining expertise in energy planning capabilities particularly for remote settings and the development of conventional and renewable energy resources.

The Solar Two power plant in Daggett, California can produce 10 MW of electric power from the sun's energy (enough for about 10,000 homes).

# Cross-Cutting Initiatives

In addition to its own portfolio of programs, OPT actively participates in a number of DOE- and EERE-sponsored initiatives that advance technologies in more than one sector of the energy economy.

## Bioenergy

Under this initiative, EERE program efforts directed at the development of biomass feedstocks, harvesting and processing technologies, industrial and consumer products, power generation, and production of alternative liquid fuels will be more closely integrated. In partnership with the U.S. Department of Agriculture (USDA), EPA, National Science Foundation (NSF), and industry, EERE is initiating the development of technology roadmaps that will identify new opportunities for synergies among existing programs and new R&D areas.

## Brightfields

This solar energy initiative helps make use of contaminated, unused factory sites, often referred to as brownfields. The Brightfields Initiative will redevelop these brownfields in cities throughout the country by bringing pollution-free solar energy and high-tech solar manufacturing jobs to these sites, including the placement of photovoltaic arrays that can reduce cleanup costs and the integration of solar energy systems as part of redevelopment.

## Climate Change Technology

The Climate Change Technology Initiative (CCTI) includes tax credits to serve as incentives for energy efficiency improvements and renewable technologies for buildings, light-duty vehicles, industry, and electricity generation. Other funding covers research, development, and deployment for energy-efficient and renewable technologies, more efficient generating technologies, and carbon sequestration research.

## Combined Cooling, Heating, and Power

Combined Cooling, Heating, and Power (CHP) or cogeneration systems are currently used in a variety of industrial applications. In December 1999, EERE issued a CHP Challenge calling on industry and government to work together to double the capacity of CHP in the U.S. by 2010 to approximately 100 GW. OPT's CHP activities are focused on eliminating barriers that continue to limit the widespread use of CHP, as well as to expand the use of CHP in commercial buildings applications.

## Energy Grid Reliability

The Department is undertaking an integrated set of activities for both the electricity and natural gas grids to allow reliable delivery of energy services to consumers in competitive, restructured energy markets. Activities in transmission reliability, distributed power, and energy storage comprise the electricity grid component.

## EnergySmart Schools

EnergySmart Schools is a DOE-led partnership that brings together public and private sector resources to reduce energy bills in our Nation's schools and redirect the savings to our children and their education. The initiative works to improve the learning environment through smart energy improvements and increases the energy awareness of students, teachers, and local communities.

This 48-story skyscraper in New York City uses thin-film PV panels to replace traditional glass cladding material along sections of the 35th to 48th floors. The building's developer used a wide variety of solar and energy efficiency strategies throughout the structure.

## GeoPowering the West

The GeoPowering the West initiative, announced by the Secretary of Energy in January 2000, will build on current and future public and private sector efforts to help bring geothermal electricity and geothermal heat to widespread portions of the West and expand its use from Albuquerque to Seattle. GeoPowering the West has set goals to supply at least 10% of the electricity needs of the West by 2020 with 20,000 MW of geothermal energy installed; meet the electric power or heating needs of at least 7 million U.S. homes through geopower by 2010; and double the number of states with geothermal electric power facilities to eight by 2006.

## Million Solar Roofs

Announced by President Clinton in June 1997, this EERE-led initiative is supporting the installation of one million solar energy systems on U.S. buildings by 2010. Working through more than 40 state and local partnerships with solar industries, electric service providers, government agencies and other organizations, the initiative eliminates barriers to solar energy use and assists in developing market demand.

## Natural Gas

EERE is coordinating and implementing research and market barrier mitigation actions to expand opportunities for clean and efficient natural gas technologies. Near term goals focus on market efficiency, market opportunities, and reducing market barrier impediments to greater natural gas use.

## Power Outage Prevention

The Department is undertaking a series of six major quick response activities to assure that electric power system reliability is maintained as the industry transitions over the near-term to competitive markets.

## Wind Powering America

Wind Powering America, announced by the Secretary of Energy in June 1999, establishes partnerships between public and private organizations to encourage the increased use of wind energy. This initiative has set a goal of providing 5% of the Nation's electricity from wind by 2020, with the Federal government setting the example by obtaining 5% of its electricity from wind energy by 2010.

## CONSUMERS

- Commercial
- Government
- Industrial
- Institutional
- Residential

## PRODUCTION / SUPPLY / DELIVERY

- Generation Companies
- Transmission Companies
- Distribution Companies
- Power Marketers
- Equipment Manufacturers
- Energy Service Companies

## GOVERNMENT / INSTITUTIONAL

- Federal, State, Local & Tribal Governments
- Regulatory Agencies
- Energy & Environmental NGOs
- Research & Educational Community
- Financial / Investment Community
- Trade Associations

**OPT relies on input from its stakeholders, partners, and customers in developing its goals and strategies**

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**Visit our website at: www.eren.doe.gov/power**

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